

# Assessment of damage to residential infrastructure in Kherson city, Kherson Oblast

April 2024 | Ukraine

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Cover image: A view on the Korabel micro-district, WorldView-3 from 25th August 2023, Copyright: ©2023 DigitalGlobe, Source: US Department of State, Humanitarian Information Unit, NextView License

## **ABOUT REACH:**

REACH is a leading humanitarian initiative providing granular data, timely information and in-depth analysis from contexts of crisis, disaster and displacement. The work of REACH directly feeds into aid response and decision-making by providing accessible and precise information on the humanitarian situation of crisis-affected populations.

Created in 2010, REACH is a joint initiative of IMPACT Initiatives, ACTED and the United Nations Operational Satellite Applications Programme (UNOSAT). REACH activities are conducted in support and within the framework of inter-agency coordination mechanisms at field and global levels to enabling more efficient aid planning and response.

# ASSESSMENT OF DAMAGE TO RESIDENTIAL INFRASTRUCTURE IN KHERSON CITY AND AGGLOMERATION

## April 2024 | UKRAINE

This situation overview presents the findings of an assessment of conflict-induced damage to residential infrastructure in Kherson City and surrounding areas conducted by REACH. This city was selected for assessment based on the extent and severity of damage it has incurred since the onset of Russia's invasion of Ukraine in February 2022.

This assessment aims to support data-driven humanitarian and recovery programming through a detailed understanding of damage to housing infrastructure. The findings are intended to support early and long-term recovery efforts to ensure the population's access to housing, utilities, essential services and livelihoods.

## Key Findings



Overall, 584 residential buildings were identified as damaged in Kherson city and the surrounding areas. This includes 531 single-family houses and 53 multi-story buildings. The estimated number of apartment units across these affected multi-story buildings is 4,819.



Among identified damaged residential buildings, 297 suffered moderate damage, 124 severe damage, 125 were destroyed, and 38 were under repair at the time of analysis. Of the single-family homes, 272 showed moderate damage, 120 severe damage, 124 were destroyed, and 15 were under repair. Of the multi-story buildings, 25 have suffered moderate damage, 4 severe damage, 1 was destroyed, and 23 were under repair.



The district of Antonivka, to the west of Kherson shows a heavy concentration of damaged buildings, with 285 objects identified as damaged. However, the majority of these buildings (282) were identified as single-family dwellings. By comparison, in Kherson city there are 46 multi-story buildings identified as damaged, with an estimated 4700 apartment units affected.



Following the Khakovka Dam breach, there was flooding both in the city and the surrounding areas. Infrastructure was primarily affected in southern Korabel district.

## Context

Kherson is the administrative centre of the Kherson Oblast in the south of Ukraine. It is a port city on the mouth of the Dnipro river, opening onto the Black Sea. In January 2022, the population was estimated at 279,131.<sup>1</sup> There is a large shipping industrial area in the southern Korabel district.

The city came under the control of the Armed Forces of the Russian Federation from March until November of 2022.<sup>2</sup> In late October, the temporary authorities began an evacuation of the city<sup>3</sup>, and after gradual advances by the Armed Forces of Ukraine over a period of weeks, Russian Armed Forces were ordered to retreat from the city on the 9th November.<sup>4</sup> The Armed Forces of Ukraine claimed to have regained control of the city from the 11th November 2022.<sup>5</sup>

The Armed Conflict Location Event Database records 251 incidents of 'political violence' between 2nd March and 11th November 2022, and 956 from 24th February 2022 until 31st March 2024, indicating a high frequency of aerial attacks.<sup>6</sup> During the conflict, the city has suffered widespread damage to its built environment. This damage has been further compounded by flooding following the breach of the Khakovka dam on 6th June 2023.<sup>7</sup> Reportedly, an area of 600 square kilometers in the Kherson region were affected.<sup>8</sup>

In November of 2023, the population was reported to be 71,000 people, around one quarter of its pre-war size.<sup>9</sup> At this time, a spokesperson for the state administration claimed that between 40 and 80 shells fell on the city on a daily basis.<sup>10</sup>

This geo-spatial damage assessment is complemented by a qualitative damage impact analysis to promote a detailed understanding of localised damage impacts, to reflect the lived experience of affected populations, and facilitate the integration of community voices in the recovery process. Damage impact analyses are based on key informant interviews with representatives of local authorities and civil society organisations, as well as focus group discussions and participatory mapping with impacted residents. REACH also produced an assessment of damage to critical infrastructure in Kherson, accessible upon request. Datasets are also available for bi-lateral sharing upon request: [impact.ukraine@impact-initiatives.org](mailto:impact.ukraine@impact-initiatives.org)

## METHODOLOGY OVERVIEW

The analysis is based on remote sensing of high-resolution satellite imagery acquired in August, September and October of 2023 from Maxar.<sup>11</sup> REACH partnered with UA Damage to produce an initial AI-assisted damage detection.<sup>12</sup> The results were verified through visual inspection, whereby each building was reviewed to confirm damage, determine its severity, and exclude non-residential structures.

This assessment distinguishes between single-household and multi-storey buildings. In the case of multi-storey buildings, an estimate of the number of floors and apartments was produced by inspecting publically available satellite and street-level imagery.<sup>13</sup> After estimating the number of dwellings in a building, a rule-of-thumb was used to calculate the potential number of people affected by damage to this building.<sup>14</sup> Damage severity was assigned to each building using the below categorisation:

**Moderate damage:** Noticeable but non-critical damage, preserving the building's overall structural soundness (i.e.: non-structural roof damage such as small holes).

**Severe damage:** Substantial damage possibly compromising the building's structural integrity (i.e. major portions of the roof or walls have collapsed or are critically compromised)

**Destroyed:** Building structural framework is critically compromised or completely failed, likely irreparably (i.e. the roof, walls, or floors have either entirely collapsed or are on the brink of collapse).

**Under repair:** At the time that the imagery was produced, there were visible signs of construction or repair work being undertaken (i.e. presence of construction equipment or materials)

This study uses the most suitable satellite images available, chosen for their quality and clarity, as required by REACH standards.

Remote sensing-based damage assessments can provide preliminary indications on required repair and reconstruction efforts ahead of detailed field assessments. Findings are limited by remote sensing methods, which are often not able to detect light damage (i.e.: broken windows or doors). More severe damage in an area can also serve as an indicator of the presence of lighter damage types within the vicinity. The assessment includes a flood model from earlier REACH outputs.<sup>15</sup>



Image: Destroyed building, with a heart drawn in the courtyard, October 2023<sup>16</sup>

## DATA ANALYSIS

### Overview

In the assessment conducted by REACH, damage was found to be concentrated in four administrative areas: central Kherson city, Chornobaivka to the northwest, Zelenivka to the northeast and Antonivka to the east. In the overview map (p.6), the heatmap indicates the concentration of damaged objects.

There is a substantial concentration of damaged residential objects in Antonivka (285/584). The neighbourhood is in close proximity to the Antonivka road bridge, which was contested by the Ukrainian and Russian armed forces throughout 2022 due to its logistical importance.<sup>17</sup> The bridge was struck multiple times throughout the year.<sup>18</sup> Residential buildings were reported to come under shelling in proximity to military positions.<sup>19</sup>

Chornobaivka, to the north, also sustained damage to residential buildings. The settlement is close to the Kherson International Airport, which was reportedly used by the Armed Forces of the Russian Federation to land aircraft, and came under fire from the Ukrainian Armed Forces from early in the conflict.<sup>20</sup>

The assessment identified 250 damaged residential objects in Kherson city itself, with substantial clusters in the Dniprovs'kyi and Korabelnyi, the banks of the Dnipro and Kosheva rivers, and in the southern part of the Korabel district.

### Part 1 - Antonivka

In the detail maps, the heatmap indicates the distribution of damage-affected residential units. Although there are 285 residential objects identified as damaged in Antonivka, 282 of them are single-family houses. By contrast, a single damaged multi-story apartment block, visible in the left-most part of the map (eastern Kherson city), was estimated to contain 252 apartments. Overall, this apartment block along with other ones damaged in Antonivka itself, were estimated to represent 813 affected residents, in comparison to 787 estimated residents of damaged single-family houses in the same area.

The blue indicates the approximate extent of flooding which occurred in the area after the Khakovka dam breach. Although the water rose significantly, this was predominantly in an area of open country. The assessment identified 75 residential buildings which showed signs of war-related damage and were in flooded areas.

### Part 2 - Northern Kherson city and Chornobaivka

The indent image shows the interspersed nature of single-family and multi-story buildings in Kherson city. In the parts of Kherson and Chornobaivka shown in detail here, just ten damaged multi-story buildings were estimated to have capacity for 7,203 residents, in comparison to 106 residents across 41 single-family houses.

Overall, 24 buildings were identified as damaged in Chornobaivka (17 shown in detail), of which four were multistory. In the selected part of Kherson city, there are 24 residential buildings identified as damaged, of which six are multi-story buildings with an estimated 2,736 apartments.

The map indicates how flood waters also reached this part of the city. The western part of Chornobaivka is shown to have been affected by flooding.<sup>21</sup>

### Part 3 - Southern Korabelnyi district and Korabel

This section shows the southern part of central Kherson, and the industrial Korabel district. There is a concentration of damaged residential buildings in the southern tip of Korabel, and three damaged multi-story buildings in the northern part of the island. 18 of the 125 buildings identified as destroyed are in the southern part of Korabel, and there are 38 shown across the selected area.

The southern parts of Kherson city were most heavily affected by the flooding following the breach of the Khakovka dam. This assessment indicates that 121 of the buildings showing signs of damage were also within the flood water's reach. The entirety of the Korabel island is shown to have been submerged.<sup>22</sup>



Image: comparison of single-family and multi-story buildings (indent part 2)<sup>23</sup>

# UKRAINE - KHERSON agglomeration, KHERSONSKA OBLAST

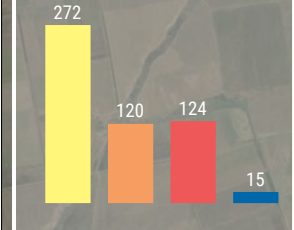
## Conflict-impacted residential buildings, August - October 2023

Estimated number of affected residents

13 803

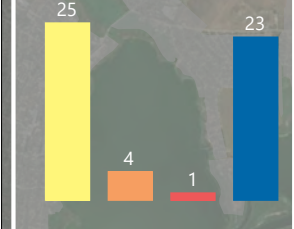
Single family houses

531



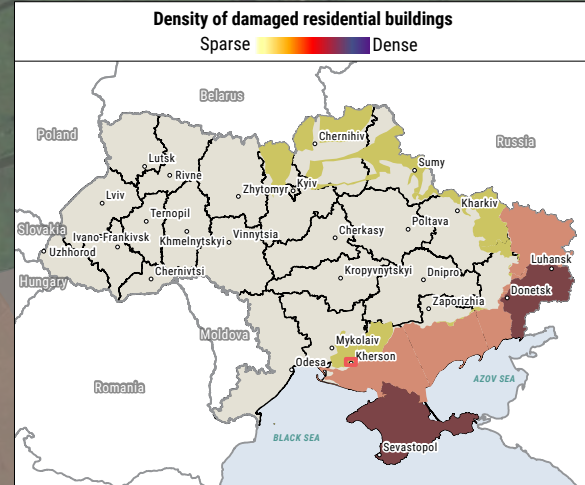
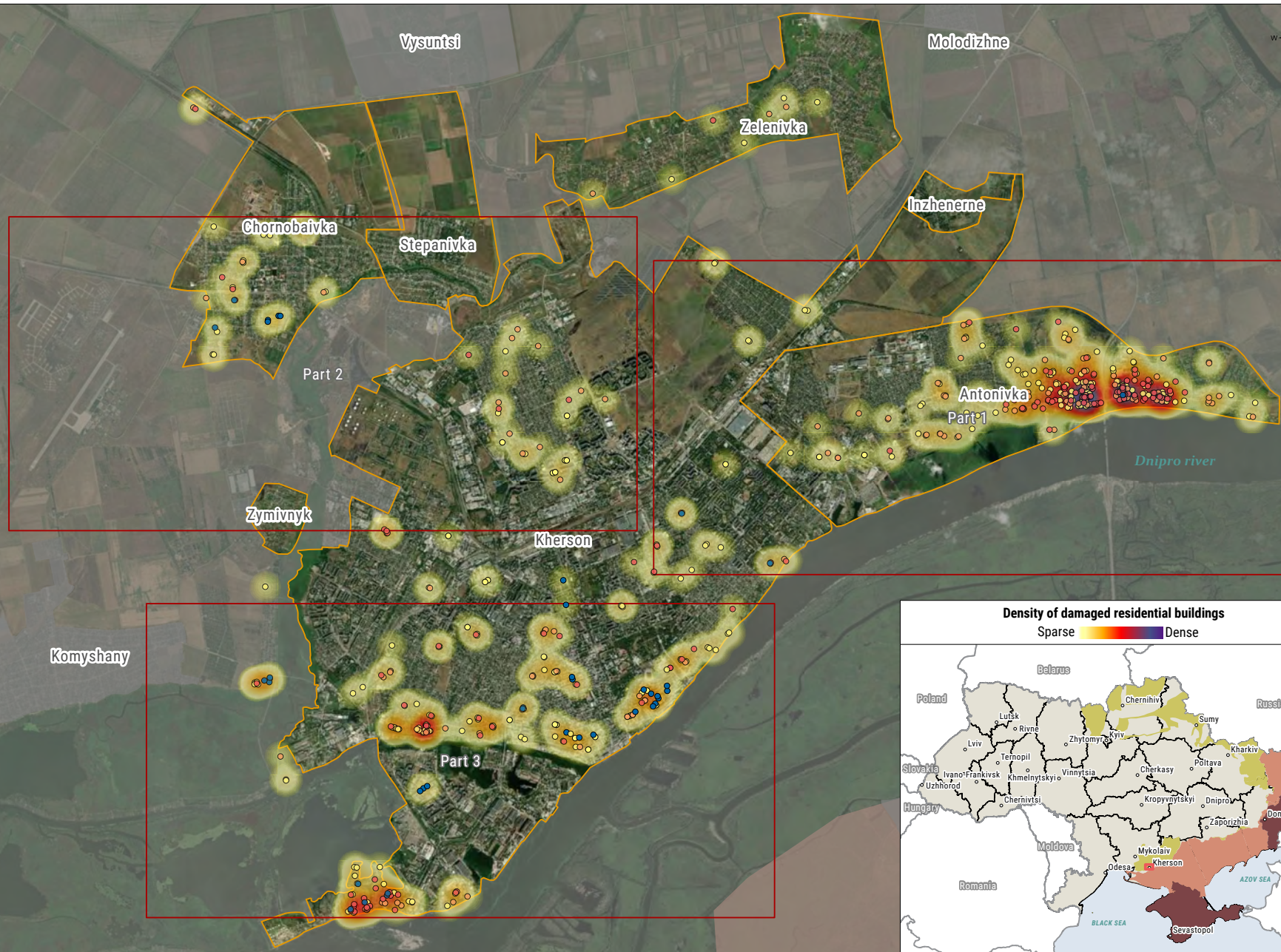
Multi-storey buildings

53



Damaged and affected by the flood

198



- Damage classification**
- Moderate damage: Limited damage to building structure
  - Severe damage: Building structure partly collapsed
  - Destroyed: All or most of the building structure has collapsed
  - Under repair: light to medium repairs have started

Data sources:  
 Administrative boundaries - OCHA  
 Imagery background - Bing  
 Damage data - REACH  
 Coordinate System: WGS 1984 UTM Zone 36N  
 Contact: reach.mapping@impact-initiatives.org

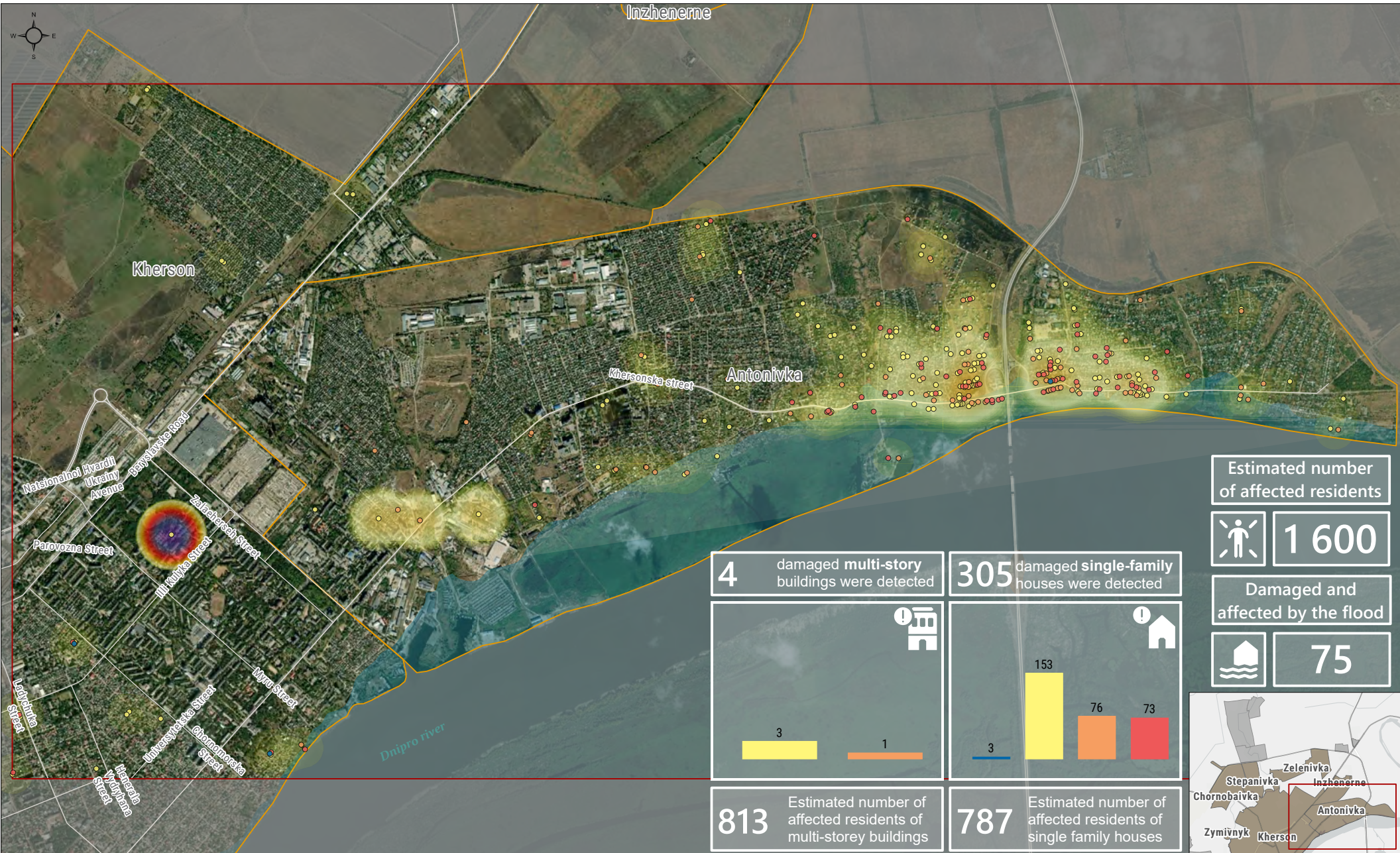
Note: Data, designations and boundaries contained on this map are not warranted to be error-free and do not imply acceptance by REACH partners, associates or donors mentioned on this map.

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- Situation map legend**
- Areas of The Autonomous Republic of Crimea, Donetsk and Luhanska Oblasts beyond the control of the Government of Ukraine since 2014
  - Areas retaken by the Government of Ukraine as of March 2024
  - Areas beyond the control of Government of Ukraine as of December 2023

# UKRAINE - KHERSON agglomeration, KHERSONSKA OBLAST, Part 1

## Conflict-impacted residential buildings, August - October 2023



Estimated number of affected residents

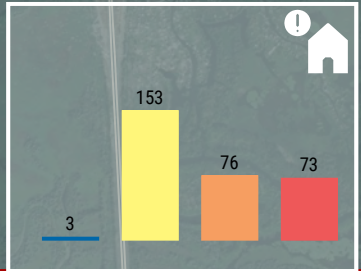
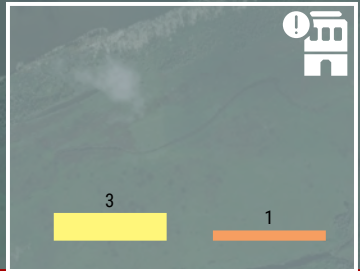
1 600

Damaged and affected by the flood

75

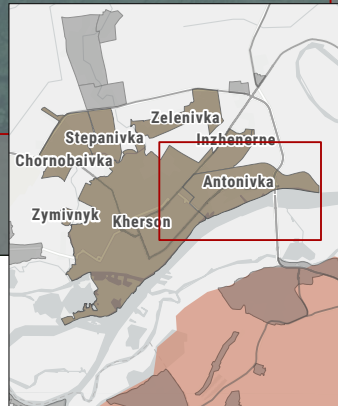
4 damaged multi-story buildings were detected

305 damaged single-family houses were detected



813 Estimated number of affected residents of multi-story buildings

787 Estimated number of affected residents of single family houses

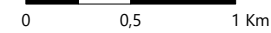


### Damage classification

- Moderate damage: Limited damage to building structure
- Severe damage: Building structure partly collapsed
- Destroyed: All or most of the building structure has collapsed
- Under repair: light to medium repairs have started

### Estimated population density in areas of detected shelter damage

- Sparse to Dense
- Administrative boundaries
- Flooded area



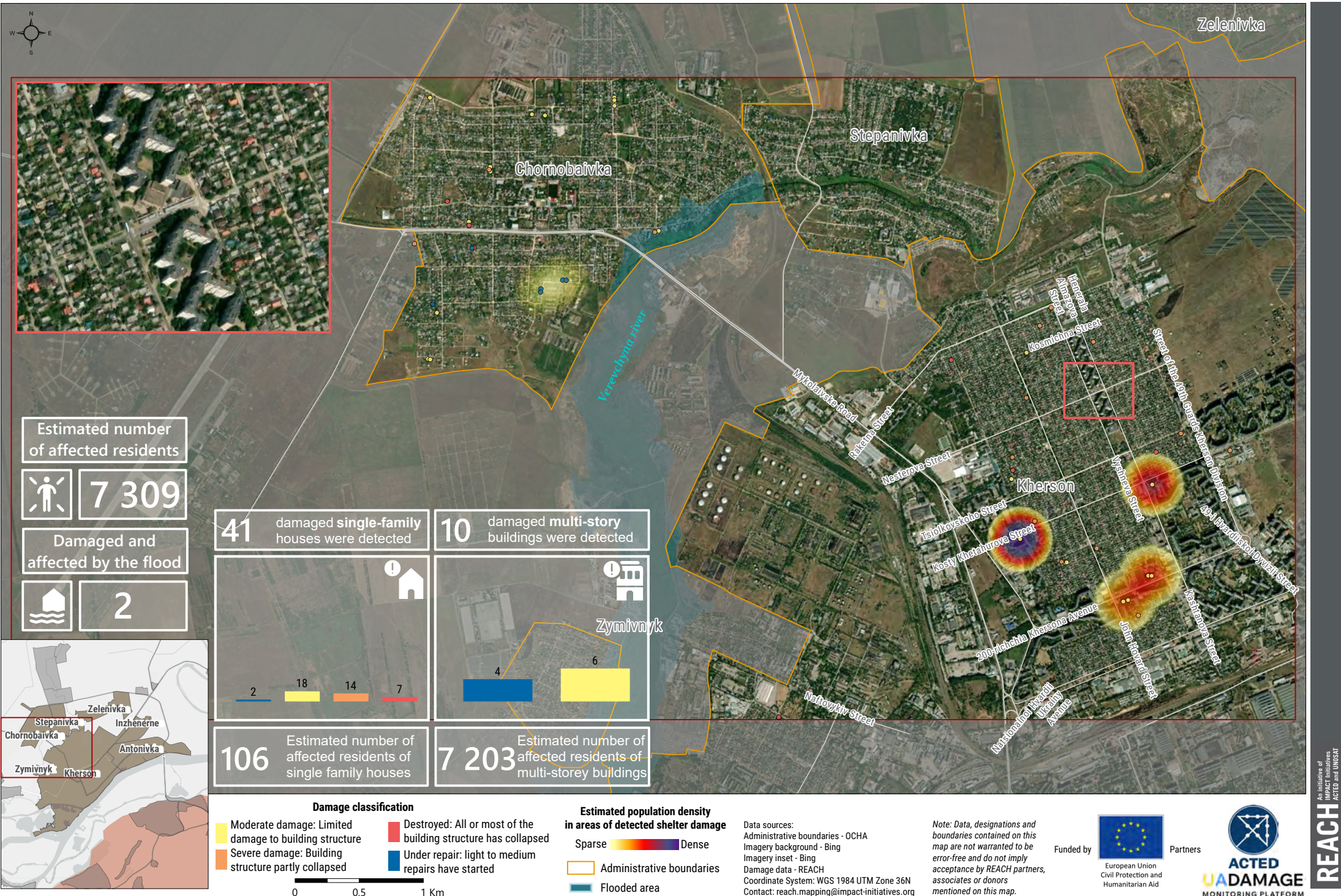
Data sources:  
 Administrative boundaries - OCHA  
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# UKRAINE - KHERSON agglomeration, KHERSONSKA OBLAST, Part 2

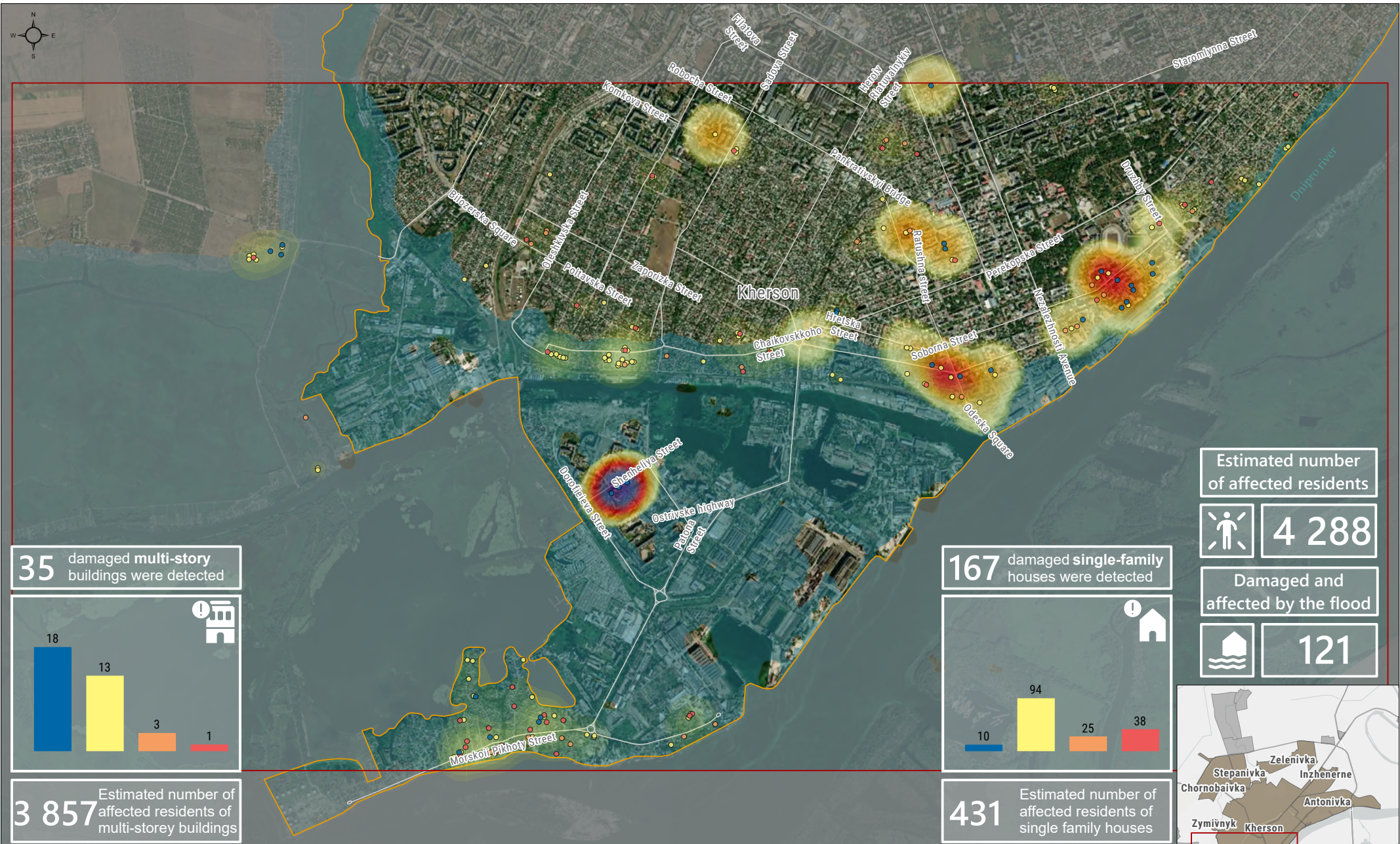
## Conflict-impacted residential buildings, August - October 2023



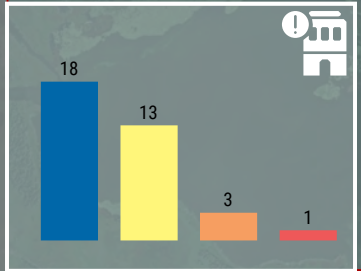


# UKRAINE - KHERSON agglomeration, KHERSONSKA OBLAST, Part 3

## Conflict-impacted residential buildings, August - October 2023

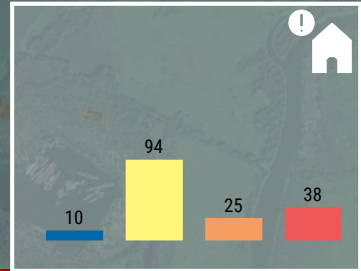


**35** damaged multi-story buildings were detected



**3 857** Estimated number of affected residents of multi-story buildings

**167** damaged single-family houses were detected

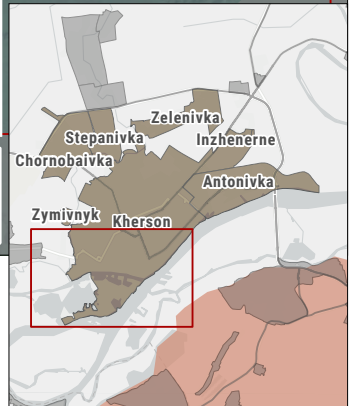


**431** Estimated number of affected residents of single family houses

Estimated number of affected residents



Damaged and affected by the flood



**Damage classification**

- Moderate damage: Limited damage to building structure
- Severe damage: Building structure partly collapsed
- Under repair: light to medium repairs have started
- Destroyed: All or most of the building structure has collapsed

**Estimated population density in areas of detected shelter damage**

- Sparse
- Dense
- Administrative boundaries
- Flooded area

0 0,5 1 Km

Data sources:  
Administrative boundaries - OCHA  
Imagery background - Bing  
Damage data - REACH  
Coordinate System: WGS 1984 UTM Zone 36N  
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## ENDNOTES

- 1 State Statistics Service of Ukraine, <https://www.ukrstat.gov.ua/>
- 2 The Independent, "[Russia claims it has seized Kherson as mayor agrees to conditions to keep city running](#)", 03/03/2022
- 3 BBC News Russia, "[‘У нас будет бойня, мы готовы’. Кто остается в Херсоне и кто его покидает](#)" trans. "'We're going to have a massacre, we're ready.' Who stays in Kherson and who leaves it", 27/10/2022
- 4 Reuters, "[Russia abandons Ukrainian city of Kherson in major retreat](#)", 09/11/2022
- 5 Deutsche Welle, "[‘Освобождение Херсона и другие события 261-го дня войны’](#)", trans. "Liberation of Kherson and other events of the 261st day of the war", 11/11/2022
- 6 Armed Conflict Location Events Database, [acleddata.com](https://acleddata.com), accessed 1st April 2024.
- 7 Associated Press, "[Major dam collapses in southern Ukraine, flooding villages as Moscow and Kyiv trade blame](#)", 07/06/2023
- 8 Deutsche Welle, "[Ukraine: Zelenskyy visits flood-hit region after dam breach](#)", 08/06/2023
- 9 Associated Press, "[One year after liberation, Ukrainians in Kherson hold on to hope amid constant shelling](#)", 11/11/2023
- 10 ibid
- 11 Satellite Imagery: WorldView3 from 25 August, 20 September, 14 October and 21 October 2023, Copyright: ©2023 DigitalGlobe, Source: US Department of State, Humanitarian Information Unit, Next-View Licence
- 12 [www.uadamage.com](http://www.uadamage.com)
- 13 [maps.google.com](https://maps.google.com)
- 14 One dwelling was approximated to accommodate 2.58 residents on average, pre-war.
- 15 See mapping of [Anotnivka](#), and [REACH Repository](#)
- 16 WorldView-3 from 14 October 2023, Copyright: ©2023 Digital Globe, Source: US Department of State, Humanitarian Information Unit, NextView License
- 17 Ukrainska Pravda, "[Invaders consider pontoon crossing instead of Antonivka Bridge in Kherson - Oblast Council](#)", 22/07/2022
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- 20 UNIAN, "[Зеленський: Чорнобаївка увійде в історію](#)", trans. "Zelenskyy: Chornobaivka will go down in history", 20/03/2022
- 21 Ukrainska Pravda, "[27 settlements still flooded on Dnipro's right bank in Kherson Oblast](#)", 14/06/2023
- 22 Deutsche Welle, "[Kherson flooded: Rescues continue under Russian fire](#)", 10/06/2023
- 23 Satellite Imagery: WorldView-3 from 14 October 2023, Copyright: ©2023 DigitalGlobe, Source: US Department of State, Humanitarian Information Unit, NextView Licence



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